

**REMARKS/ARGUMENTS**

**Status of Application**

Claims 1-32 are pending. Claim 30 is being amended to cure a typographical error.

The claims stand finally rejected for obviousness in view of Oki (JP-58125698), Ishizumi (EP-A-0683249), and McInerney (U.S. Patent No. 6,143,082). Applicant is submitting a Declaration of Professor Simon Peter Watkins, an expert in the field of semiconductor physics, in support of a request for reconsideration of the prior art rejection.

**The Prior Art Rejection**

Claims 1-32 stand finally rejected for obviousness in view of Oki (JP-58125698), Ishizumi (EP-A-0683249), and McInerney (U.S. Patent No. 6,143,082). The Examiner has articulated the rejection as follows:

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine the Oki, McInerney et al. and Ishizumi et al. disclosures because then the temperatures at which the raw materials were decomposed could be more easily controlled as suggested by Oki et al. (see page 3 of the translation, 1st full para.), and McInerney et al.

In respect to claims, 1-4, 6, 8-10, 15, 31-32 it would have been obvious to one of ordinary skill in the art at the time of the present invention to perform a method of epitaxial growth of a material on a substrate including decomposition of multiple gas precursors in a separate and sequential manner at different temperature using different heating mechanisms because separate heating and gas supply are suggested by the presented references. Oki et al. suggests multiple heating devices in such a method. Also, in respect to the limitations of efficiently decomposing precursors and reduction of time from decomposing to combination at the region on the surface, obviousness is not deficient even if the prior art has a different reason for doing what the applicant has done. [In re Kronig, 190 USPQ 425 (CCPA 1976)]

Applicant respectfully requests reconsideration and withdrawal of the prior art rejection, both for the reasons previously presented, and further in view of the enclosed Declaration of Professor Simon Peter Watkins.

As will be discussed in greater detail below, Professor Watkins is an expert in the field of semiconductor physics and is the head of the MOCVD Laboratory at Simon Fraser University, located in Vancouver, British Columbia. MOCVD is an acronym for metalorganic chemical vapor deposition. Further, Professor Watkins has had first-hand experience with a

reactor (the Titan machine), supplied to his laboratory by EMF Ireland Limited, the assignee of the present invention. The Titan machine embodies much of what is described and claimed in the present application.

The Claimed Invention Distinguishes over the Prior Art

The claims define the invention, and the following discussion should be taken in that context. It is believed, however, that the following is a fair characterization of the claims.

As previously pointed out, the beneficial effect of the invention, elaborated on below, is caused by the “holistic” combination of three different factors, all of which are recited in all the independent claims. These are:

- a) The separate heating of the precursors to their respective (efficient) decomposition temperatures;
- b) The provision of the decomposition “at or adjacent” the substrate such that the species produced by at least one of the decomposition reactions are able to reach the substrate without taking part in unfavorable reactions along the way; and
- c) The separate and sequential supply of these species to the substrate which again prevents unwanted reactions and therefore provides a high quality product using a mono-epitaxy mechanism.

Applicant respectfully submits that this combination is nowhere disclosed or suggested by the prior art.

The invention provides extra degrees of freedom for processing different materials. For example, if one of the precursors decomposes efficiently at the same temperature as the growth temperature, there is no need to heat the substrate to a different temperature than the decomposition temperature for that precursor. On the other hand, if the material grows efficiently at a different temperature to the efficient decomposition temperatures of the precursors, separate provision can be made to maintain the substrate at the suitable growth temperature. Claims 1 and 16 are generic to both these cases. Claim 30 addresses the first case where the substrate is heated to generally the same temperature as one of the precursors.

Dependent claims 31 and 32 address the second case, reciting maintaining the substrate at a third temperature that is different from the first and second temperatures.

Further, decomposing the precursors at or adjacent the substrate provides additional capability for those cases where the species are atoms which are prone to recombination. The invention does not require that the materials being deposited require the generation of atomic species, but is readily adaptable to such applications, and suitably configured can produce high purity materials efficiently and also produce materials, heretofore difficult to produce outside the laboratory, with industrial viability.

The Watkins Declaration Provides Strong Evidence in Favor of Patentability

Inappropriateness of the Combination

Professor Watkins characterized the Ishizumi, Oki, and McInerney references in Paragraphs 8-10 of the Declaration generally as follows:

- Ishizumi describes an atomic layer epitaxy (ALE) method, for monoepitaxy, in which two precursors are supplied to a substrate individually. The precursors are injected at the top of the growth chamber (1) via inlets (2) and (3) respectively, and the only heating in the apparatus is applied to the substrate in accordance with the known ALE method.
- Oki, by way of contrast, describes a Metal Organic Vapor Phase Epitaxy (MOVPE) method for heteroepitaxy, which is quite different. While one of the precursors is decomposed by a heater (7) which is separate from the heater (3) for heating the substrate, the *Oki heteroepitaxy method requires, as an essential element, the mixing of the decomposed species above the substrate.*
- McInerney describes a multi-station processing system, the primary point of which is the growth of a stack of distinct “incompatible” materials such as silicon and tungsten hexafluoride grown in completely different physical regions. This is fundamentally different from the present invention in which separate deposition of two of the atomic constituents is supplied in an alternating process with the aim to create a uniform material composition.

Professor Watkins also opined, in Paragraphs 15 and 16 of the Declaration, that the present invention represents a significant advance over the teachings of Ishizumi, Oki, and McInerney, and explained as follows why such a combination would be unlikely:

... Ishizumi and Oki relate to mutually exclusive techniques, each having its own disadvantages, and further ... McInerney does not suggest anything relevant to this hypothetical combination. More specifically, Oki discloses a separate heater for one of the precursors, Oki requires the mixing of gases above the substrate. Thus Oki provides no guidance of how to provide a second heater to Ishizumi which has a moving baffle to maintain the two gases separated. I do not believe the McInerney reference provides any guidance for resolving this conflict.

In my opinion as an expert in the field of MOCVD, a scientist would not have combined the references in the manner described by the Examiner. For example, Ishizumi and Oki illustrate two mutually exclusive methods of depositing semi-conductor materials: the Metal Organic Vapour Phase Epitaxy (MOVPE) as described in Oki, and Atomic Layer Epitaxy (ALE) as described in Ishizumi. The MOVPE approach relies upon the mixing of precursors in the gaseous phase above the substrate. In contrast, ALE requires that there is no such mixing and rather that the species are supplied to the substrate individually.

### Unexpected Results

In Paragraphs 11-13 of the Declaration, Professor Watkins described experiments using the Titan machine to manufacture single-crystal aluminum nitride. This is normally difficult, but the results were excellent. Professor Watkins states in Paragraph 17 of the Declaration:

I was extremely surprised by the results of the experiments and in particular that high crystalline quality AlN can be produced directly using the deposition method in the '350 application. Furthermore, I was equally surprised to achieve such excellent results in a mere three days, running one test per day.

### Combining the Prior Art References Can Only Occur through Hindsight Reconstruction

The Examiner cited *In re Kronig*, 190 USPQ 425 (CCPA 1976), for the proposition that obviousness is not deficient even if the prior art has a different reason for doing what the applicant has done. Applicant respectfully submits that *Kronig* is not on point since the references there were closely linked, as opposed to being incompatible as in the present case. The claim in *Kronig* recited "the production of allyl acetate in which propylene, oxygen and acetic acid are reacted together in the gaseous phase at elevated temperature in the presence of a three component catalyst" and further recited the addition of water. The references (and their relevant teachings) relied on by the Board were as follows:

	Holzrichter et al.	Yasui et al.	Swift
allyl acetate	process for preparing allyl acetate in which propylene, oxygen, and acetic acid are reacted together	---	---
	corresponding process for preparing vinyl acetate by reacting together ethylene, oxygen, and acetic acid	prepare vinyl acetate from ethylene, oxygen, and acetic acid	prepare vinyl acetate from ethylene, oxygen, and acetic acid
water	---	product yields are increased by using acetic acid having a high water content	---
iron in catalyst	---	---	co-catalyst or promoter, such as iron, either as the free metal or in compound form, serves to stabilize the selectivity of the noble metal catalyst, for example palladium

The passage of *Kronig* quoted by the Examiner should be viewed in its context.

The Court, upheld the rejection with the following analysis:

In their brief, appellants argue that Holzrichter et al. fail to disclose the addition of water or the use of an iron compound in the catalyst, as recited in appellants' claims. However, as discussed above, Yasui et al. and Swift disclose these very features. Appellants urge that Yasui et al. and Swift are strictly limited to the production of vinyl acetate, not at issue here. We disagree. Whereas Holzrichter et al., Yasui et al., and Swift are threaded by their common disclosure of preparing vinyl acetate from ethylene, Holzrichter et al. further disclose the analogous preparation of allyl acetate from propylene. We believe that one of ordinary skill in the art would have been motivated to apply the teachings of Yasui et al. and Swift to the Holzrichter et al. process in order to obtain improvements therein, and we view the combination of references as being apt. Appellants further allege that the effect of water addition which they disclose (to lengthen the service life of the catalyst) is different from the effect of water addition disclosed in Yasui et al. Nevertheless, Yasui et al. provide ample motivation to add water in order to increase product yields, and we do not view the rejection as deficient merely because appellants allege a different advantage resulting from the addition of water.

Thus, in *Kronig*, the references had the strong common disclosure of preparing vinyl acetate by reacting together ethylene, oxygen, and acetic acid. This is a very different scenario than the

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present case, where Ishizumi and Oki are dealing with mutually exclusive techniques, and McInerney added nothing to the mix.

Accordingly, the rationale of *Kronig* is inapplicable here, and Applicant respectfully requests reconsideration and withdrawal of the obviousness rejection.

**CONCLUSION**

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance and an action to that end is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,

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Attached: Declaration of Simon Peter Watkins

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